

CAN ALBATROSSES AND AIRCRAFT COEXIST ON MIDWAY ATOLL?

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Summary

Aircraft collisions with birds (bird strikes), especially Laysan albatrosses (Diomedea immutabilis), have been a problem at Midway Naval Air Facility since at least the 1950s. The U.S. Navy in 1993 reported 57 strikes during 459 aircraft movements. We visited Midway from 15-21 April 1995 to determine the species composition and diurnal pattern of bird flights over Runway 6-24 so that recommendations could be made regarding timing of aircraft movements to minimize strikes. Midway Atoll in 1994-1995 had an estimated 450,000 nesting pairs of albatrosses (900,000 adults), a mean density of 725 nests/ha. We recorded a mean of 363 birds (89% Laysan albatrosses) crossing the runway/minute during daylight hours. At night (2230-2300), we estimated only 5.7 birds/minute (89% Bonin petrels [Pterodroma hypoleuca]) flying over the runway, a 98.5% reduction over mean numbers during daylight. As Midway Atoll goes through the transition from military base to wildlife refuge, nonemergency aircraft movements should be restricted to night from November-mid July. Furthermore, any plans to develop "ecotourism" or other activities for the Atoll will need to factor in this constraint for aircraft movements. Under present conditions, daytime aircraft movements for commercial or private carriers would raise serious safety and liability issues..

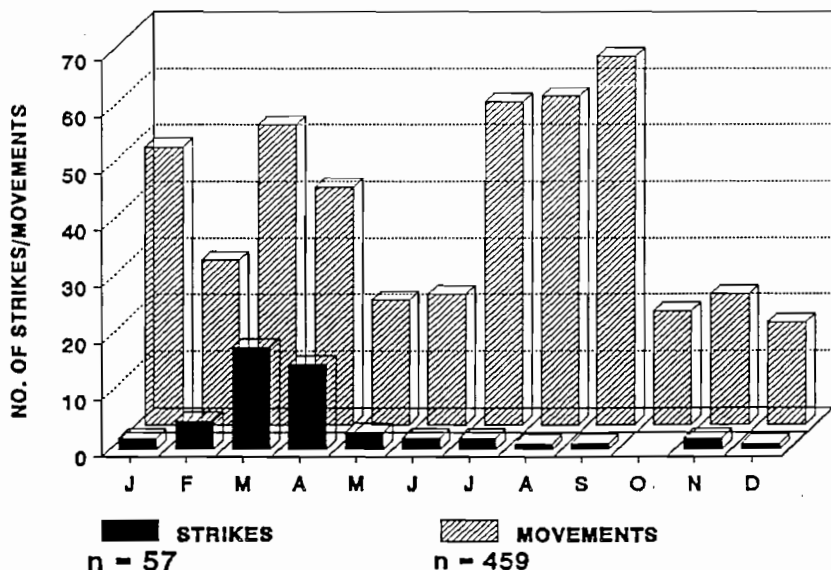
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1. INTRODUCTION

Midway Atoll, 2,100 km northwest of Honolulu, Hawaii, contains 2 main islands 1.5 km apart: Sand Island (485 ha) and Eastern Island (135 ha). Midway Naval Air Facility (MNAF), established in 1941, presently maintains a 2,440-m runway (6-24) on Sand Island. Eastern Island is uninhabited. The U. S. Fish and Wildlife Service (USFWS), under a Cooperative Agreement with the U.S. Navy (USN), has administered a National Wildlife Refuge on the Atoll since 1988.

Aircraft collisions with birds (bird strikes), especially Laysan albatrosses (*Diomedea immutabilis*), have been a problem at MNAF since at least the 1950s (Aldrich 1958, Kenyon et al. 1958, Rice 1959, Fisher 1966a). Although aircraft movements at Midway presently are reduced relative to 1950-1970 levels (the USN is in the process of an environmental clean-up program to close MNAF), there are still sufficient aircraft movements to warrant concern over bird strikes. For example, the USN in 1993 reported 57 strikes during 459 aircraft movements (1,200 strikes/10,000 movements, Fig. 1) which is 210 times the strike rate (5.7/10,000 movements) for commercial airlines (Thorpe 1990). In addition, civilian aircraft movements soon may begin at Midway if an "ecotourism" industry develops after the MNAF closure (K. Niethammer, USFWS, Pers. Commun.).

FIGURE 1. Number of aircraft movements and reported bird strikes at Midway Naval Air Facility, Midway Atoll, 1993 (Unpubl. data, U.S. Navy).



Laysan and black-footed (*D. nigripes*) albatrosses arrive and initiate egg laying/incubation (1 egg/nest) at Midway in November. Eggs hatch in January and each chick is fed primarily squid by the adult pair until July when fledging occurs. A population of subadult birds, equivalent to 10-25% of the nesting population of adults, is also present (Aldrich 1958, Rice and Kenyon 1962, Fisher 1966a). Albatrosses are absent from the Atoll from mid July-November.

We visited Midway from 15-21 April 1995 to survey the albatross population at the midpoint of the nesting season in relation to the airfield. Our specific objective was to determine the species composition and diurnal pattern of bird flights over Runway 6-24 so that recommendations could be made regarding timing of aircraft movements to minimize strikes.

2. METHODS

The USFWS provided estimates of nesting populations of albatrosses and other birds on Midway Atoll (USFWS, unpubl. data). To measure bird flight activity at the airfield, we counted the number of birds crossing Runway 6-24 during 104 10-minute observation periods over 5 days (16-20 April). The runway was divided into 8 305-m (1,000-ft) sectors delineated by distance markers along runway sides. For each observation period, an observer, positioned 50 m outside the runway edge at the center of a sector, counted all birds that crossed the sector during each 1-minute interval for 10 minutes. During the final (10th) 1-minute count, the observer also recorded the species of each bird. With 4 people observing, the entire runway (8 sectors) was observed during a 30-minute interval (2 10-minute observations with 10 minutes to move between sectors). Observation times were randomly assigned daily with the constraint that the entire runway was observed once during each daylight hour (0600-1900) over the 5 days. Observers rotated among sectors.

In addition, 1 10-minute observation was made in each sector at night on 20 April from 2230-2300 hr. Observers used binoculars and counted birds by species flying across the runway between 2 sets of runway lights (61-m widths or 1/5 the width of sectors used in daylight). Numbers crossing the entire runway were projected by multiplying by 5.

To compare numbers of birds crossing the runway among runway sectors and daylight hours, a 2-way analysis of variance test was conducted (Statistix 1994). A LSD test was used to determine differences ($P \leq 0.05$) among means. The mean number of birds/minute during each 10-minute observation was the response variable. Day and nighttime numbers were not compared with statistical tests.

3. RESULTS

3.1 Albatross Population Levels and Annual Cycle

Midway Atoll in 1994-1995 had an estimated 450,000 nesting pairs of albatrosses (900,000 adults), a mean density of 725 nests/ha (Table 1, Fig. 2). Including non-nesting adult birds, the population of after-hatching-year (AHY) birds likely exceeded 1 million individuals and the population of AHY birds and chicks reached 1.4 million in February (Fig. 3).

TABLE 1. Estimated population of nesting adult and total after-hatching year (AHY) albatrosses, Midway Atoll, 1994-1995.

Island	No. of nesting adult birds*			Total AHY birds ^b
	Black-footed	Laysan	Total	
Sand	18,452	340,000	358,452	430,000
Eastern/spit	21,060	520,000	541,060	650,000
Total	39,512	860,000	899,512	1,080,000

* Unpubl. data (U.S. Fish and Wildl. Serv., Midway Atoll Nat. Wildl. Refuge).

^b Assuming population of nonbreeding AHY birds is about 1/6 the total population of AHY birds on the islands (estimates have ranged from 10-25% [Aldrich 1958, Rice and Kenyon 1962, Fisher 1966a]).

TABLE 2. Numbers and species composition of birds crossing Runway 6-24 during daylight ($n = 104$ 10-min observations) and at night ($n = 8$ 10-min observations), Midway Atoll, 16-20 April 1995.

Species	Mean no. crossing/min. (% of total)	
	Daylight (0610-1855)	Night (2230-2300)
Laysan albatross	321.9 (89)	0.4 (7)
Black-footed albatross	11.8 (3)	0 (0)
White tern	16.3 (4)	0.2 (4)
Sooty tern	5.5 (1)	0 (0)
Bonin petrel	<0.1 (<1)	5.1 (89)
Other*	12.7 (3)	0 (0)
Total	362.7 (100)	5.7 (100)

* Red-tailed tropicbird (Phaethon rubricauda), lesser golden plover (Pluvialis dominica), black noddy (Anous minutus), brown noddy (Anous stolidus), great frigatebird (Fregata minor), ruddy turnstone (Arenaria interpres), and bristle-thighed curlew (Numenius tahitiensis).

FIGURE 2. Estimated number of nesting Laysan albatrosses on Midway Atoll, 1900-1995. Data for 1900-1957 are from Rice and Kenyon (1962), for 1961-1963 from Fisher (1966a,b), and for 1995 from U.S. Fish and Wildlife Service, Midway Atoll National Wildlife Refuge (Unpubl. data).

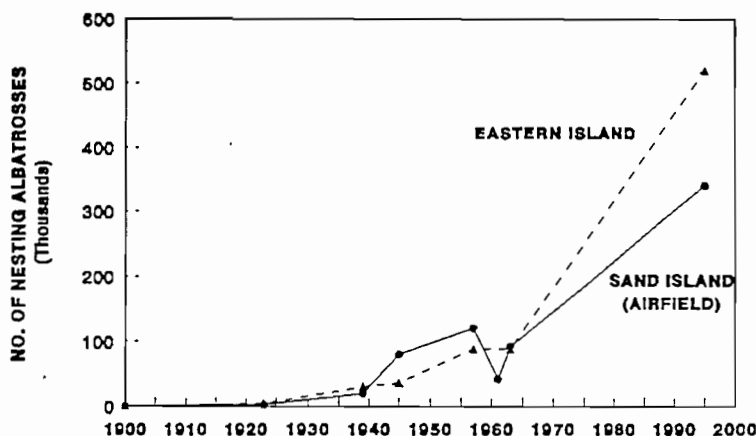
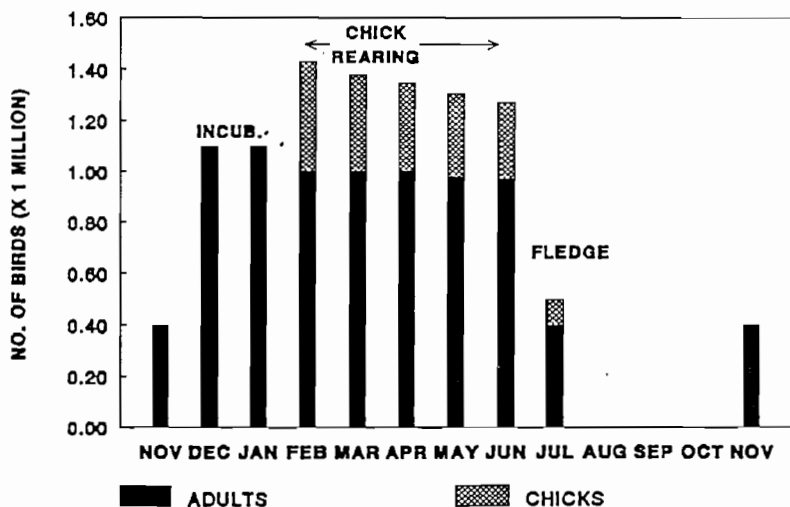


FIGURE 3. Approximate annual cycle of Laysan (96%) and black-footed (4%) albatrosses on Midway Atoll, November 1994-November 1995, based on population censuses (Table 1) and mean reproductive and survival rates (Rice and Kenyon 1962, Fisher 1976).



All available nesting habitat (unpaved areas of grass and forest/brush understory) were occupied by albatrosses. Densities in open grass areas, the most preferred habitat, exceeded 2,000 nests/ha (Fig. 4). Laysan and black-footed albatrosses comprised 96% and 4% of the population, respectively.

FIGURE 4. Typical density of Laysan albatross chicks and adults in open, grass habitat, Sand Island, Midway Atoll, April 1995 (Photo by R. A. Dolbeer).



3.2 Bird Flights over Runway 6-24

We recorded a mean (SD) of 363 (170) birds crossing the runway/minute during daylight hours (Table 2). Laysan albatrosses comprised 89% of the birds followed by white terns (*Gygis alba*), black-footed albatrosses and sooty terns (*Sterna fuscata*) (1-4%). Bird crossings varied among hours ($F = 12.31$; 12, 84 df; $P < 0.01$), being most frequent between 0701-1100 and 1501-1700 (435-525/minute). However, even the least active daylight hour (1301-1400) averaged 205 birds/minute over the runway (Fig. 5). Runway Sector 5 (1525-1830 m from start of Runway 6) had the highest ($F = 5.56$; 7, 84 df; $P < 0.01$) mean crossing rate (67 birds/minute) but the other 7 runway sectors also had substantial activity (38-48 birds/minute) (Fig. 6).

At night (2230-2300), we estimated only 5.7 birds/minute flying over the runway, a 98.5% reduction over mean numbers during daylight (Table 2, Fig. 5). Bonin petrels (*Pterodroma hypoleuca*) comprised 89% of the birds followed by

FIGURE 5. Mean number of birds crossing Runway 6-24 per minute by hour of day, Midway Naval Air Facility, 16-20 April 1995 (Mean hourly values with same letter above bar are not different [$P > 0.05$]).

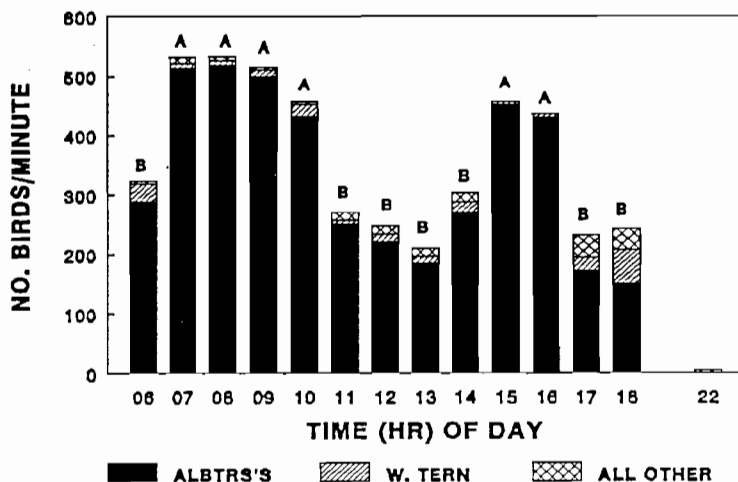
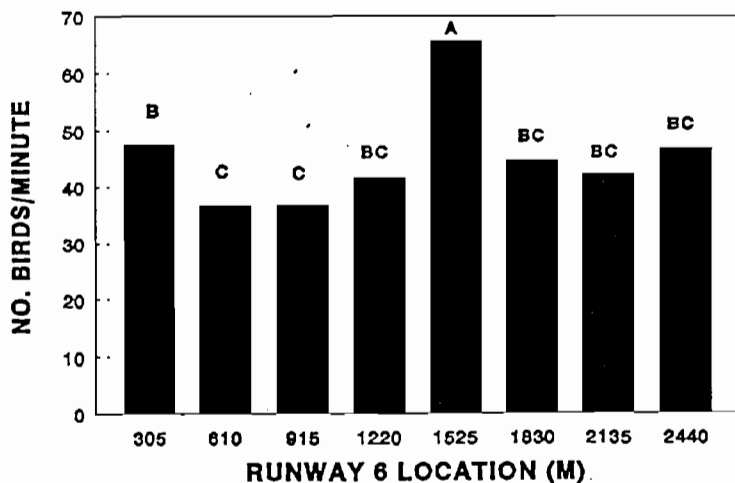


FIGURE 6. Mean number of birds crossing 8 305-m sectors of Runway 6-24 per minute during daylight hours (0610-1855), Midway Naval Air Facility, 16-20 April 1995 (Mean sector values with same letter above bar are not different [$P > 0.05$]).



albatrosses (7%) and white terns (4%). From the perspective of bird strikes, the reduction in bird activity at night was even more pronounced because the mean mass of a Bonin petrel (0.18 kg) is only about 6% that of a Laysan albatross (2.85 kg [female], 3.23 kg [male]) (Dunning 1993).

4. DISCUSSION

The population of albatrosses on Midway Atoll is apparently at an all-time high (Fig. 2). This population growth has resulted from human-induced (by importing top soil and plants) transition of the islands since 1900 from sand-covered, mostly barren land (Fisher 1949) to areas covered with grass, trees (mainly ironwood [*Casuarina* sp.]), and shrubs (*Scaevola* sp.). Apparently there were only negligible numbers of albatrosses at Midway prior to human occupation around 1900 (Rice and Kenyon 1962) but the population has steadily increased since then. Temporary declines noted in the 1950s (Fig. 2) were a result of population control programs in which well over 60,000 adults and 200,000 eggs were destroyed (Fisher 1966a).

All open, unpaved habitat on Midway appeared to us to be fully occupied by albatross nests in April 1995. Further population increases may be contingent upon new habitat openings as old buildings and ironwood plantings are removed and vegetation encroaches on abandoned pavement areas.

Regardless of whether albatross populations increase or not, current numbers, coupled with the continuous daytime flights over Runway 6-24 (\bar{x} = 363 birds/minute), make aircraft movements at Midway hazardous during daylight hours from November-mid July. It is also important to note that Sector 5 (where the greatest flight activity occurred, see Fig. 6) is where rotation (lift-off and maximum engine thrust) occurs for many aircraft departing Midway. Finally, albatross body mass (3 kg) substantially exceeds the maximum bird mass (1.8 kg) the U.S. Federal Aviation Administration specifies for engines to ingest without catastrophic failure (Code of Federal Regulations, 1995). The probability of damage to an aircraft engine increases with the mass of the bird ingested (Hovey et al. 1991:67-72).

In conclusion, as Midway Atoll goes through the transition from military base to wildlife refuge, nonemergency aircraft movements should be restricted to night from November-mid July. Furthermore, any plans to develop "ecotourism" or other activities for the Atoll will need to factor in this constraint for aircraft movements. Under present conditions, daytime aircraft movements for commercial or private carriers would raise serious safety and liability issues.

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